National Aeronautics and Space Administration

Lighting Automation Flying an Earthlike Habitat

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HAT: 6.3, 6.4, 7.4 TA: 6.4 Human Health & Performance, 7.4 Habitat Systems TRL: start 3 / current 5

OVERVIEW

Currently, spacecraft lighting systems are not demonstrating innovations in automation due to perceived costs in designing circuitry for the communication and automation of lights. The majority of spacecraft lighting systems employ lamps or zone specific manual switches and dimmers. This type of “hardwired” solution does not easily convert to automation. If we are to build long duration environments, which provide earth-like habitats, minimize crew time, and optimize spacecraft power reserves, innovation in lighting automation is a must.

INNOVATION

This project researched the use of the DMX512 communication protocol originally developed for high channel count lighting systems. Our goal is to enable the development of automated spacecraft habitats for long duration missions. To transform how spacecraft lighting environments are automated, our project conducted a variety of tests to determine a potential scope of capability. We investigated utilization and application of an industry accepted lighting control protocol, DMX512 by showcasing how the lighting system could help conserve power, assist with lighting countermeasures, and utilize spatial body tracking.

INFUSION SPACE / EARTH

Implementation of this technology at a system level to fully automate the lighting system and integrate it with the avionics command and control system would revolutionize the human interface to a spacecraft lighting system by enabling spacecraft efficiencies while enhancing the operational environment.

FUTURE WORK

It is a paradigm shift to migrate spacecraft lighting controls to an automated system maintained by the spacecraft. Future work should investigate human integration and systems engineering challenges.

2017 ICA Poster – EISD Technology Showcase

OUTCOME

Circadian Lighting Countermeasure

A Red-Green-Blue-White (RGBW) Pixel LED strip was used to generate a multi-spectrum light output. Utilizing Madrix® a lighting control application, a set of colors that represented warm, neutral, and cool white light was put into a timed function. The software interpolated the dimming intensity ranges for each color channel such that the apparent “color” of the white light has the proper gradient from one color of white to the next over a range of times. For demonstrations purposes, the simulation provides an accelerated representation of a 24 hour circadian lighting countermeasure.

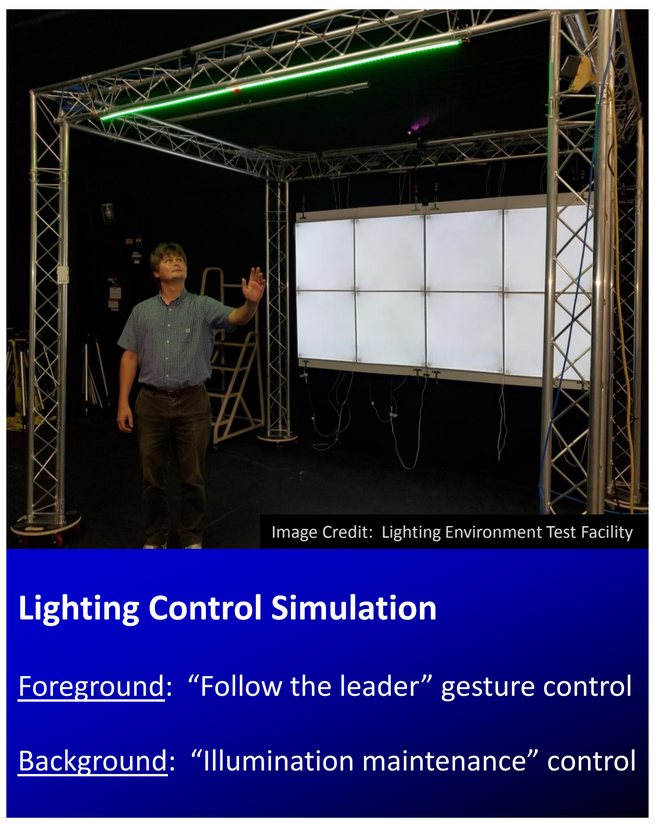

Image Credit: Lighting Environment Test Facility

Lighting Control Simulation

Foreground: “Follow the leader” gesture control

Background: “Illumination maintenance” control

Illumination Maintenance (Steady State Light Levels)

The simulation utilized a set of signal channel LED light panels with Pulse Width Modulated dimming provided by a DMX512 decoder. The lighting control system utilized a Madrix® lighting control application, scripts, and real time USB illuminance light sensor data, and C++ coding. An open loop control algorithm provided direction for increasing or decreasing lighting intensity until the light sensor data fell within a threshold.

Follow the Leader

To advance the concept of occupancy sensors and lighting where it is only needed, a simulation was developed that made a group of LEDs on a LED pixel strip follow the movement of a hand waving near the light strip. The simulation used a Kinect® camera, a RGBW LED pixel strip, a RGBW pixel LED strip, a DMX512 compatible pixel decoder, a DMX controller, C++, scripts, and a Madrix® lighting control application. The simulation successfully demonstrated the used of 3D position monitoring devices to control the state of a light with respect to that lamp’s location in 3D space.

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